



(19) Japan Patent Office (JP)  
(12) Laid-Open Patent Report (A)  
(11) Laid-open patent application no.  
H7-42893  
(43) Date laid open: February 10, 1995

(51) Int. Cl.<sup>6</sup>: Ident. code: Internal control no.: FI Technical Display Location  
F 16 L 59/02

Inspection requested: No  
Number of claims: 5  
(Total 4 pages)

(21) Application no.: H5-194421

(22) Application date: August 5, 1993

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(54) {Title of Invention} Soundproofing heat-insulating material, its method of manufacture and method of use

(57) {Summary}

{Purpose} To obtain a soundproofing heat-insulating material that has excellent heat-insulating effects and soundproofing effects, and that can be installed very easily in narrow places.

{Structure} Shape memory polyester sheets for surface sheets are glued together to fabricate a honeycomb-structure body 1 which is 3-cm thick, and this is heated to 120°C so that the shape memory material memorizes the honeycomb structure. Then, the honeycomb structure is compressed from above and below and folded while being heated to 70-90°C to provide a honeycomb-structure body 1', which is then wrapped in an aluminum-laminated film 2. This is connected to a vacuum pump, evacuated and then sealed. The soundproofing heat-insulating material thus obtained is 1 cm or less in thickness, has a heat conductivity of 0.008 Kcal/mh°C, and has improved heat-insulating characteristics so that it is about 1.5 times as effective as conventional materials made from polyurethane foam. Also, it has improved soundproofing effects so as to be about 1.5 times as effective. In addition, the honeycomb-structure body 1' can be very easily installed in a 2.5-cm space inside the body of a refrigerator.

Key to figure (b)

Evacuation

## Specification

### ***{Scope of the Patent Claims}***

{Claim 1} Soundproofing heat-insulating material in which a honeycomb-structure body made of shape memory plastic is wrapped in airtight film and evacuated, then sealed airtight.

{Claim 2} A soundproofing heat-insulating material as stated in claim 1 in which the shape memory plastic is shape memory polyester thin sheet.

{Claim 3} A soundproofing heat-insulating material as stated in claim 1 in which the airtight film is aluminum-laminated film.

{Claim 4} A method of manufacture of soundproofing heat-insulating material in which a honeycomb-structure body is fabricated using shape memory plastic sheets, and it is made to memorize the honeycomb structure of the aforementioned honeycomb-structure body, and the honeycomb structure of the aforementioned memorized honeycomb-structure body is folded, it is wrapped in airtight film and evacuated, then sealed.

{Claim 5} A method of use of soundproofing heat-insulating material in which the honeycomb structure of a honeycomb-structure body fabricated using shape memory plastic sheets is memorized in advance, and the honeycomb structure of the aforementioned honeycomb-structure body is folded, it is wrapped in airtight film and evacuated, then sealed, and the heat-insulating material thus fabricated is installed in any place, and it is made to return to the shape of the initial honeycomb structure by heating.

### ***{Detailed Explanation of the Invention}***

{0001}

{Industrial Field of Use} This invention pertains to a soundproofing heat-insulating material. In particular, it pertains to a soundproofing heat-insulating

material characterized in that a honeycomb-structure body fabricated of shape memory plastic is wrapped in airtight film and evacuated, then sealed airtight, and to its method of manufacture and method of use.

{0002}

{Prior Art} In the past, plastics were known whose various characteristics such as heat insulation, soundproofing, buoyancy, elasticity and lightness of weight were improved by making plastic into foam using mechanical means, reactive gas or foaming agents. Such plastic foams have been widely used as soundproofing materials, heat-insulating materials, construction materials, light-weight structural materials, packaging materials, insulating materials, cushion materials, vibration damping materials, footwear and so forth.

{0003}

{Problems the Invention is to Resolve} Recently it has become desirable to improve heat-insulating ability and soundproofing ability with as thin a shape as possible in order to save energy, save resources and save space. The best means of improving heat-insulating ability and soundproofing ability per unit thickness is to evacuate the inside of heat-insulating material. However, the generally-known method of individually evacuating the inside of consecutive air bubbles of plastic foam by a vacuum pump is inefficient.

{0004}

{Means for Resolving Problems} To resolve the aforementioned problem, the soundproofing heat-insulating material of this invention is a material in which a honeycomb-structure body fabricated of shape memory plastic is wrapped in airtight film and evacuated, then sealed airtight.

{0005} In the aforementioned structure, it is desirable if the shape memory plastic is shape memory polyester thin sheets. Also, in the aforementioned structure, it is desirable if the airtight film is aluminum-laminated film.

{0006} A method of manufacture of the soundproofing heat-insulating material of this invention is one in which a honeycomb-structure body is fabricated using shape memory plastic sheets, and it is made to memorize the honeycomb structure of the aforementioned honeycomb-structure body, and the honeycomb structure of the aforementioned memorized honeycomb-structure body is folded, it is wrapped in airtight film and evacuated, then sealed.

{0007} A method of use of the soundproofing heat-insulating material of this invention is one in which the honeycomb structure of a honeycomb-structure body fabricated using shape memory plastic sheets is memorized in advance, and the honeycomb structure of the aforementioned honeycomb-structure body is folded, it is wrapped in airtight film and evacuated, then sealed, and the heat-insulating material thus fabricated is installed in any place, and it is made to return to the shape of the initial honeycomb structure by heating.

{0008}

{Operation} By means of the aforementioned soundproofing heat-insulating material of this invention, a soundproofing heat-insulating material with excellent soundproofing effects and excellent heat-insulating effects can be achieved because a honeycomb-structure body fabricated of shape memory plastic is wrapped in airtight film and evacuated, and sealed airtight.

{0009} Also, by means of the preferred structure of this invention in which the shape memory plastic is shape memory polyester thin sheets, a soundproofing heat-insulating material that can be installed very easily in narrow places and that has excellent heat insulation can be achieved.

{0010} Also, by the preferred structure of this invention in which the airtight film is aluminum-laminated film, the heat insulation effect can be further increased because the heat radiation of the soundproofing heat-insulating material is small.

{0011} By the method of manufacture of the soundproofing heat-insulating material of this invention, the aforementioned soundproofing heat-insulating material can be manufactured efficiently. Also, by the method of use of the soundproofing heat-insulating material of this invention, installation of the heat-insulating material is very easy because the honeycomb structure of a honeycomb-structure body fabricated using shape memory plastic sheets is memorized in advance, and the honeycomb structure of the aforementioned honeycomb-structure body is folded, it is wrapped in airtight film and evacuated, then sealed, and the heat-insulating material thus fabricated is installed in any place, and it is made to return to the shape of the initial honeycomb structure by heating.

{0012}

{Implementation Examples} The method of manufacture of this invention includes a process in which a honeycomb-structure body is fabricated using shape memory plastic sheets, a process in which the honeycomb structure of the aforementioned honeycomb-structure body is memorized, a process in which the honeycomb structure of the aforementioned honeycomb-structure body is folded, and a process in which it is wrapped in airtight film and evacuated, then sealed. Also, it is characterized in that, when used, it is made to return to the shape of the initial honeycomb structure by heating.

{0013} The shape memory plastic used in the soundproofing heat-insulating material of this invention can be polyester, transpolyisoprene, polynorbornene, styrene-butadiene copolymer, polyurethane and the like, but among these materials, shape memory polyester is preferred because it has excellent processability and heat insulation. In order to fabricate a honeycomb-structure body from shape memory plastic, it can be molded using injection molding, extrusion molding, blow molding and so forth, using general thermoplastic

polymer molding machines. In order to make the shape memory plastic memorize the honeycomb structure, after the honeycomb-structure body is molded, it is made to memorize the shape by performing a heating process for several minutes at 120-180°C using a hot blow dryer. While heating the shape memory plastic which has memorized the honeycomb structure to at least 50°C, preferably 70-90°C, it is deformed into any shape, and when it is cooled to room temperature while maintaining this state, it is solidified as is while deformed. When this deformed molded body is again heated to at least 50°C, it returns to the original honeycomb-structure body. Therefore, installation of the heat-insulating material becomes very easy because the shape memory plastic that has memorized a honeycomb structure can be returned to the initial shape of the honeycomb structure by heating after it is installed in any place as a heat-insulating material.

{0014} The airtight film used in the soundproofing heat-insulating material of this invention preferably has a thickness of approximately 200-250 microns. This invention is explained with reference to the diagrams.

### ***{0015} Implementation Example 1***

First, a 3-cm-thick honeycomb-structure body 1 was fabricated by gluing together shape memory plastic for surface sheets (copolymer made of shape memory polyester sheets, aromatic polyester segments and aliphatic polyester segments made by Nippon Ester Co., with melting point of 250°C and glass transition point of 80°C). After that, this honeycomb-structure body 1 was made to memorize the honeycomb structure by heating to 120°C (figure 1 (a)). Then, the honeycomb structure was compressed from above and below and folded while being heated to 70-90°C. In addition, this folded honeycomb-structure body 1' was wrapped in aluminum-laminated film 2 (thickness approximately

215 microns) made by laminating approximately 15-micron-thick aluminum on polyester film, and it was connected to a vacuum pump, and sealed by evacuating to a degree of vacuum of less than 1 mHg (Figure 1 (b)). Also, as a comparison example, a honeycomb-structure body 1' was wrapped in polyester film (polyethylene terephthalate) approximately 200 microns thick, and it was similarly evacuated and sealed.

{0016} The heat-insulating material created in this way had a thickness of less than 1 cm, and when the heat conductivity was measured, it was 0.008 Kcal/mh°C, which is an improvement in the heat insulating characteristics of approximately 1.5 times compared to conventional polyurethane foam heat-insulating materials. Also, the soundproofing effect was also improved 1.5 times.

{0017} After that, it was installed in a space of 2.5 cm inside the body of a refrigerator, and then again heated to 70-90°C. When this was done, it was returned to the shape of the compressed honeycomb-structure body, and the heat-insulating material expanded until it filled the space (figure 1 (c)).

{0018} In this case, installation of the heat-insulating material that was less than 1 cm thick into a 2.5-cm space was very easy. Furthermore, the heat-insulating material whose shape was restored in this way returned on its own to a thickness of 2.5 cm, close to the original thickness of 3 cm, and when heat conductivity was measured, it was 0.004 Kcal/mh°C, which was an improvement in the heat insulation characteristics of about 2 times compared to conventional polyurethane foam. Also, the soundproofing effects were also improved about 2 times. On the other hand, the comparison example, which was sealed with polyester film alone, had somewhat poor heat insulation. Also, when the degree of vacuum was measured after one year of storage, the degree

of vacuum had greatly degraded. The degree of vacuum of this implementation example, which was sealed with aluminum-laminated film, had not degraded.

{0019}

{Effect of the Invention} As described above, by the method of this invention, installation of the heat-insulating material is very easy because the shape of the initial honeycomb structure is restored by heating after the heat-insulating material is installed in any place. Also, its heat insulation effects and soundproofing effects as a heat-insulating material can be improved because the spaces inside the aforementioned honeycomb structure are evacuated and sealed with airtight film. In addition, heat radiation can be reduced due to the fact that the airtight film surface is wrapped with metal thin sheet.

### ***{Brief Explanation of the Diagrams}***

{Figure 1} Cross-sectional diagram of process that schematically shows method of manufacture and method of use of an implementation example of this invention. (a) is an oblique diagram of the honeycomb-structure body that has memorized the shape, (b) is a cross-sectional diagram of the heat-insulating material in which the honeycomb structure has been folded and evacuated and sealed with aluminum-laminated film, (c) is a cross-sectional diagram of the installed state of the heat-insulating material which has been installed in the body of a refrigerator and then returned to the shape of the compressed honeycomb structure by heating.

### ***{Explanation of Code Numbers}***

- 1, 1' ... Shape memory honeycomb-structure body
- 2 ... Aluminum-laminated film
- 3 ... Refrigerator

***Key to figures***

Figure 1(b)      Evacuation

(19)日本国特許庁 (JP)

(12) 公開特許公報 (A)

(11)特許出願公開番号

特開平7-42893

(43)公開日 平成7年(1995)2月10日

(51)Int.Cl.<sup>6</sup>

識別記号

庁内整理番号

F I

技術表示箇所

F 16 L 59/02

審査請求 未請求 請求項の数5 OL (全4頁)

(21)出願番号 特願平5-194421

(22)出願日 平成5年(1993)8月5日

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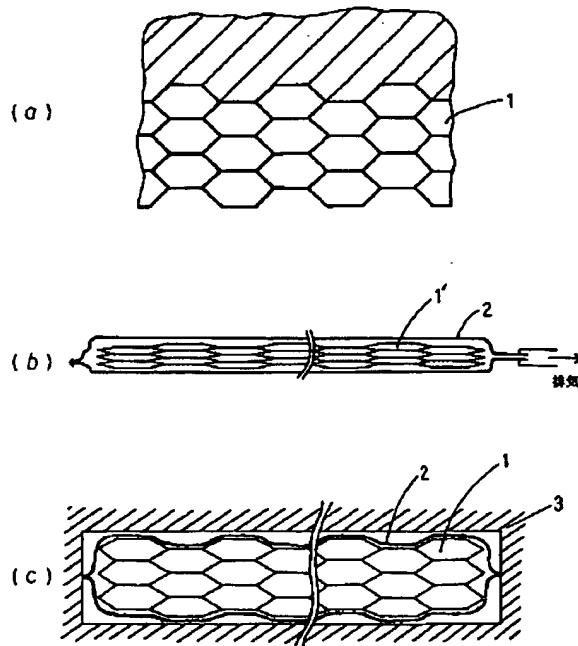
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(54)【発明の名称】 防音断熱材、その製造方法及び使用方法

(57)【要約】

【目的】 断熱効果や防音効果に優れ、狭い場所にもきわめて容易に設置できる防音断熱材を得る。

【構成】 面板用の形状記憶ポリエスチル板を貼合させ、厚み3cmのハニカム構造体1を作製し、120°Cに加熱してハニカム構造を記憶させる。次に、70~90°Cで加熱しながら上下より圧縮してハニカム構造を折りたたみハニカム構造体1' とし、これをアルミラミネートフィルム2で包み込み、真空ポンプに接続し、排気後密封する。得られた防音断熱材は、厚みが1cm以下となり、熱伝導率は0.008Kcal/mh°Cであり、発泡ポリウレタンの従来例に比べ約1.5倍断熱特性を改善できる。また、防音効果も約1.5倍改善されている。さらにハニカム構造体1' は冷蔵庫のボディー内の2.5cmの間隙にきわめて容易に設置できる。



## 【特許請求の範囲】

【請求項1】 形状記憶性樹脂で作製したハニカム構造体を気密性のフィルムで被い内部を排気した後、気密封止した防音断熱材。

【請求項2】 形状記憶性樹脂が形状記憶ポリエチル薄板である請求項1に記載の防音断熱材。

【請求項3】 気密性のフィルムがアルミラミネートフィルムである請求項1に記載の防音断熱材。

【請求項4】 形状記憶性樹脂板を用いハニカム構造体を作製し、前記ハニカム構造体のハニカム構造を記憶させ、前記記憶されたハニカム構造体のハニカム構造を折りたたみ、気密性のフィルムで被い内部を排気した後封止する防音断熱材の製造方法。

【請求項5】 あらかじめ形状記憶性樹脂板を用いて作製したハニカム構造体のハニカム構造を記憶させ、さらに前記ハニカム構造体のハニカム構造を折りたたみ、気密性のフィルムで被い内部を排気した後封止して作製した断熱材を任意の場所に設置し、加熱して初期ハニカム構造の形状を復元させる防音断熱材の使用方法。

## 【発明の詳細な説明】

## 【0001】

【産業上の利用分野】 本発明は、防音断熱材料に関する。さらに詳しくは、形状記憶樹脂で作製したハニカム構造体を気密性のフィルムで被い内部を排気した後気密封止したことを特徴とした防音断熱材、その製造方法及び使用方法に関する。

## 【0002】

【従来の技術】 従来、プラスチックを機械的に発泡させたり反応性ガスを用いて発泡させたり発泡剤を用いて発泡させることにより、断熱、吸音、浮力、弾力、軽量等の諸特性を改善できることが知られており、このような発泡プラスチックは防音材や断熱材、建材、軽量構造材、包装材、絶縁材料、クッション材、防震材、履物等に広く利用されている。

## 【0003】

【発明が解決しようとする課題】 最近では、省エネルギー、省資源、省スペースのため、できるだけ薄い形状で断熱性をよくしたり防音性をよくすることが望まれている。単位厚みあたりの断熱性や防音性をよくするために、断熱材内部を真空にすることが最も良い手段である。しかしながら、一般に知られているような真空ポンプで発泡プラスチックの連続気泡内部を個々に真空にする方法は非能率であった。

## 【0004】

【課題を解決するための手段】 前記課題を解決するため、本発明の防音断熱材は、形状記憶性樹脂で作製したハニカム構造体を気密性のフィルムで被い内部を排気した後、気密封止したものである。

【0005】 前記構成においては、形状記憶性樹脂が形状記憶ポリエチル薄板であることが好ましい。また前

記構成においては、気密性のフィルムがアルミラミネートフィルムであることが好ましい。

【0006】 次に本発明の防音断熱材の製造方法は、形状記憶性樹脂板を用いハニカム構造体を作製し、前記ハニカム構造体のハニカム構造を記憶させ、前記記憶されたハニカム構造体のハニカム構造を折りたたみ、気密性のフィルムで被い内部を排気した後封止するものである。

【0007】 次に本発明の防音断熱材の使用方法は、あらかじめ形状記憶性樹脂板を用いて作製したハニカム構造体のハニカム構造を記憶させ、さらに前記ハニカム構造体のハニカム構造を折りたたみ気密性のフィルムで被い内部を排気した後封止して作製した断熱材を任意の場所に設置し、加熱して初期ハニカム構造の形状を復元させるものである。

## 【0008】

【作用】 前記本発明の防音断熱材によれば、形状記憶性樹脂で作製したハニカム構造体を気密性のフィルムで被い内部を排気した後、気密封止したので、断熱効果や防音効果に優れた防音断熱材を達成できる。

【0009】 また形状記憶性樹脂が形状記憶ポリエチル薄板である本発明の好ましい構成によれば、狭い場所にも極めて容易に設置でき、かつ熱絶縁に優れた防音断熱材を達成できる。

【0010】 また気密性のフィルムがアルミラミネートフィルムである本発明の好ましい構成によれば、防音断熱材の熱輻射を少なくできるのでさらに断熱効果を高められる。

【0011】 次に本発明の防音断熱材の製造方法によれば、前記防音断熱材を効率良く合理的に製造できる。次に本発明の防音断熱材の使用方法によれば、あらかじめ形状記憶性樹脂板を用いて作製したハニカム構造体のハニカム構造を記憶させ、さらに前記ハニカム構造体のハニカム構造を折りたたみ気密性のフィルムで被い内部を排気した後封止して作製した断熱材を任意の場所に設置し、加熱して初期ハニカム構造の形状を復元させるので、断熱材の設置がきわめて容易となる。

## 【0012】

【実施例】 本発明の製造方法は、形状記憶性樹脂板を用いハニカム構造体を作製する工程と、前記ハニカム構造体のハニカム構造を記憶させる工程と、前記記憶されたハニカム構造体のハニカム構造を折りたたむ工程と、気密性のフィルムで被い内部を排気した後封止する工程とを含んでいる。また、使用の際は、加熱して初期ハニカム構造の形状を復元させることを特徴とする。

【0013】 本発明の防音断熱材に用いる形状記憶性樹脂は、例えばポリエチル、トランスポリイソブレン、ポリノルボルネン、スチレン-ブタジエン共重合体、ポリウレタンなどがあげられるが、中でも形状記憶ポリエチルが加工性や熱絶縁に優れ好ましい。形状記憶性樹

脂でハニカム構造体を作製するには、射出成形、プレス成形、押出成形、ブロー成形等、一般的な熱可塑性ポリマー用成形機を用いて成形する。形状記憶性樹脂にハニカム構造を記憶させるには、ハニカム構造体を成形した後、熱風乾燥機等で120～180℃で数分間熱処理を行って形状を記憶させる。ハニカム構造を記憶させた形状記憶性樹脂は、50℃以上、好みしくは70～90℃で加熱しながら、任意の形に変形させ、その状態を保持したまま室温まで冷却すると変形したまま固定する。この変形した成形体を再び50℃以上に加熱すると元のハニカム構造体に戻る。従って、ハニカム構造を記憶させた形状記憶性樹脂を断熱材として任意の場所に設置した後加熱して初期ハニカム構造の形状を復元させて用いることで、断熱材の設置がきわめて容易となる。

【0014】本発明の防音断熱材に用いる気密性のフィルムは厚さ約200～250μmであることが好ましい。以下図面を用いて本発明を説明する。

#### 【0015】実施例1

あらかじめ、面板用の形状記憶樹脂（日本エスチル社製の形状記憶ポリエスチル板、芳香族ポリエスチルセグメント及び脂肪族ポリエスチルセグメントからなるコポリマーで、融点250℃、ガラス転移点80℃のもの）を貼合わせ、厚み3cmのハニカム構造体1を作製した。その後、このハニカム構造体1を120℃に加熱してハニカム構造を記憶させた（図1（a））。次に、70～90℃に加熱しながら上下より圧縮してハニカム構造を折りたたんだ。さらに、この折りたたまれたハニカム構造体1'をポリエスチルフィルムの上に厚さ約15μmのアルミニウムをラミネートしたアルミラミネートフィルム2（厚さ約215μm）で包み込み、真空ポンプに接続し真空度が1mHg以下になるまで排気して密封した（図1（b））。また、ハニカム構造体1'を厚さ約200μmのポリエスチルフィルム（ポリエチレンテレフタレート）で包み、同様に排気して密封し、比較例とした。

【0016】このようにして作成された断熱材は、厚みが1cm以下となり、熱伝導率を測定すると0.008Kcal/mh°Cであり、従来の発泡ポリウレタンの断熱材に比べ約1.5倍断熱特性を改善できた。また、防音効果も1.5倍程度改善されていた。

【0017】その後、冷蔵庫のボディー内の隙間が2.5cmの場所に設置した後で再び70～90℃に加熱した。すると、圧縮されていたハニカム構造体の形状が復元され、断熱材が隙間いっぱいになるまで膨張した（図1（c））。

【0018】このとき、2.5cmの隙間に1cm弱の厚みの断熱材を設置したため、設置はきわめて容易であった。なお、このようにして形状の復元された断熱材そのものは、厚みが元の3cmに近い2.5cmとなり、熱伝導率を測定すると0.004Kcal/mh°Cであり、従来の発泡ポリウレタンのものに比べ約2倍断熱特性を改善できていた。また、防音効果も2倍程度改善されていた。一方、ポリエスチルフィルムだけで封止した比較例は、やや熱絶縁が悪かった。また、一年間保管した後に真空度を測定すると真空度が大幅に劣化していた。アルミラミネートフィルムで封止した本実施例では真空度は劣化していなかった。

#### 【0019】

【発明の効果】以上述べてきたように、本発明の方法を用いれば、断熱材を任意の場所に設置した後加熱して初期ハニカム構造の形状を復元させて用いることで、断熱材の設置がきわめて容易となる。また、前記ハニカム構造の内部空間は気密性のフィルムで排気減圧封止されているので、断熱材としての断熱効果や防音効果を向上できる。さらに、気密性のフィルム表面を金属薄膜で包むことにより、熱輻射も低減できる。

#### 【図面の簡単な説明】

【図1】本発明の一実施例の製造工程および使用方法を概念的に示した工程断面図である。（a）は形状記憶させられたハニカム構造体の斜視図、（b）は、ハニカム構造が折りたたまれてアルミラミネートフィルムで減圧封止された断熱材の断面図、（c）は、冷蔵庫のボディー内の隙間に設置した後で加熱し、圧縮されていたハニカム構造の形状を復元させた断熱材の設置状況の断面図を示す。

#### 【符号の説明】

- 1, 1' 形状記憶ハニカム構造体
- 2 A1ラミネートフィルム
- 3 冷蔵庫ボディー

【図1】

